

In ECE 480, my team (team 2) is responsible for building a testbed with a geolocator for RF emitters. This project is heavy in the antenna aspect of electromagnetics engineering. Some of the ideas I was working with involved the electromagnetics side of this project and the Ultimate GPS Breakout V3. In this application note, I'll go through the success the class has had with me as an individual while going through some previously discussed goals in the class.

When the project brainstorming was well on its way, we had to begin thinking about

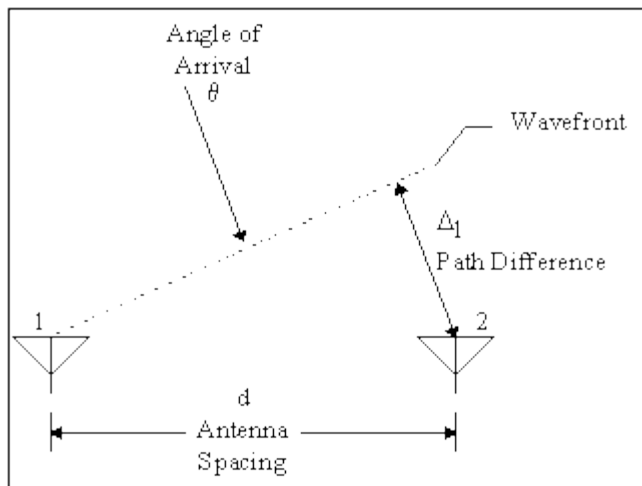


Figure 1: Visual of how angle of arrival is derived

some of the constrictions and parameters the project is presenting/will present. First of those things was the most important: Angle of Arrival. With angle of arrival, I immediately knew that multiple antennas were to come into play. Typically, angle of arrival estimation is performed using an antenna array, in which the phase

difference between the received signals at each array element is mapped to the incident direction of the signal. So essentially, I had to determine what kind of antennas would best fit our needs to best complete the project requirements as effectively as possible. Also, as always,

money has to be kept in mind because the successfulness of the project was also scaled on how much money has to be spent on each part. To do this, I had to research certain types of antennas and determine which would fit our needs and whether there is room to cut cost on the parts being considered. The antenna I decided would do all of this was the standard monopole antenna commonly used RF applications in the real world.

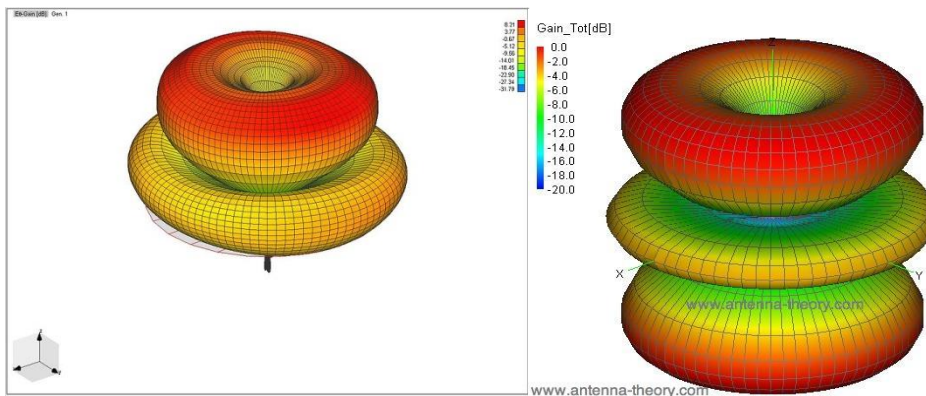


Figure 2: $3\lambda/2$ Monopole antenna vs $3\lambda/2$ Dipole Antenna

Using knowledge that I gained in ECE 405, I knew to observe the radiation charts of specific antennas to decide on which to use.

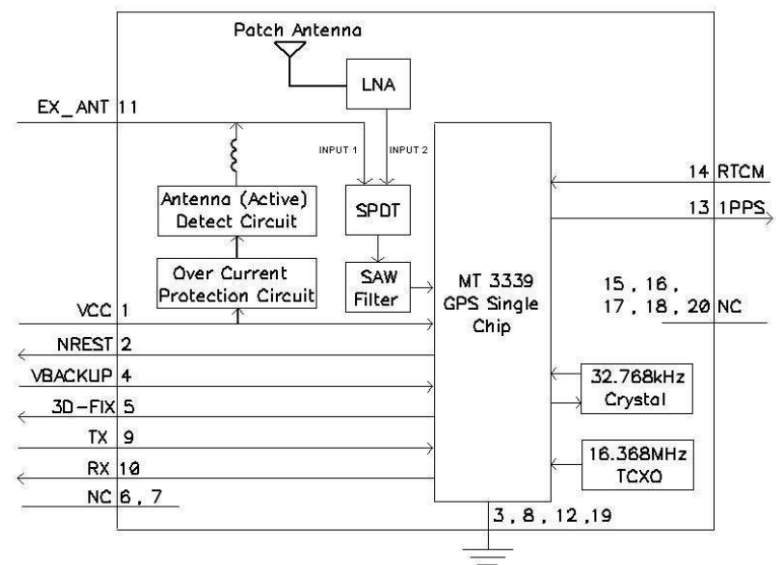
When doing so, it was pretty elementary thinking to decide on the monopole antenna after also considering a dipole antenna and the patch antenna. For convenience, I cut out the dipole antenna because when comparing between the monopole and dipole, the radiation charts are nearly the same (Figure 2). With that said, a monopole antenna can also be as effective and present a +3dB gain when comparing to the dipole. Before explaining our chosen antenna, it's important to remember that because of angle of arrival, we had to cut down on our frequency band because the wavelength of signals below 60 MHz is far too long for us. This is because in order to calculate AOA, you must have two antennas a certain distance apart and having them 300m apart is not very convenient or realistic for 1 MHz waves since $= \frac{c}{f}$. With that said, I proposed we chose a monopole antenna that that could be readily available somewhere in the middle of our

frequency band. We ended up choosing an 800 MHz monopole antenna that Joe made available to us through the RF department at the physics plant at MSU.

Also, I have helped design the ultimate GPS breakout V3 for the location portion of our project. We chose this GPS unit

because of its ultra-high sensitivity (-165dBm w/o a patch antenna) and its low power consumption at 25mA (since our final geolocator has to be portable meaning we can't have a bunch of components drawing unnecessary current from our DC power source). On the right in figure 3 is a system block diagram

1.3 System Block Diagram



of the FGPMMPA6H GPS. The pins we will need are pin 1 (V_{cc}), Pins 3 8 12 and 19 (GND), Pin 4 (V_{backup}) for the battery, and pins 9 and 10 to transmit and receive data to the GPS. This GPS will be connected to the Beaglebone Black microcontroller that will talk to it and help display where our signals are coming from using GPS-GPRS communication protocol.